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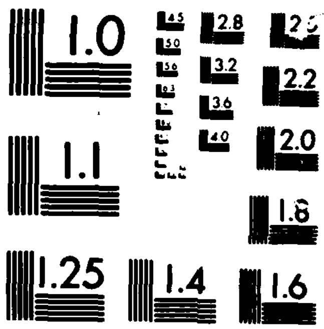

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NAVAL POSTGRADUATE SCHOOL

Monterey, California

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COMMAND AND CONTROL IN THE FLEET BATTLE GROUP AN ORGANIZATIONAL APPROACH

by

Anneliese Lillard Kennedy

March 1986

Thesis Advisor: Carl R. Jones

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This thesis contains a brief overview of past developments in command and control, and applies organizational theory to the design of systems for tactical command and control, specifically within the context of the Fleet Battle Group. By applying Ashby's theory of requisite variety and Mintzberg's five coordinating mechanisms, a general model of tactical warfare is provided. The author proposes a balanced application of the five coordinating mechanisms to the problems of command and control within the battle group, or other tactical combatant organization.

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Command and Control in the Fleet Battle Group
An Organizational Approach

by

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Submitted in partial fulfillment of the
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ABSTRACT

This thesis contains a brief overview of past developments in command and control, and applies organizational theory to the design of systems for tactical command and control, specifically within the context of the Fleet Battle Group. By applying Ashby's theory of requisite variety and Mintzberg's five coordinating mechanisms, a general model of tactical warfare is provided. The author proposes a balanced application of the five coordinating mechanisms to the problems of command and control within the battle group, or other tactical combatant organization.

DISCLAIMER

The reader is cautioned that material concerning nuclear and tactical operations not specifically referenced are the author's opinion, and are the results of past shipboard and staff experience in fleet exercises and in wargames. Individual experts may differ with these opinions and subsequent findings.

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ACKNOWLEDGEMENTS

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I. THE PROBLEM OF FLEET COMMAND AND CONTROL

> Command and Control strikes me as being one of the Navy's greatest problems. We talk it to distraction but I don't believe we have a concept of what it is, how to go about it, what we need, or for that matter what the words "Command" and "Control" are intended to imply. [Ref. 1: p. 1]

In recent years there has been great emphasis on the development of a command and control theory in order to answer the doubts raised by Captain W.S. Whaley in the above statement. Much of this work has been done in the fields of operations research, cybernetics and computer science. Recently, attention has also focused on the contribution that may be made from studies in organizational control theory. In this thesis, the author hopes to apply certain theories of organizational control to the problems of C2, including elements in the areas of personnel, procedures, equipment and training that contribute to the overall C2 environment.

First, the author will give a brief background concerning past work in command and control, with an emphasis on problems encountered in information processing and communications. From there, an examination will be made of principles of cybernetic and organizational control theory which will form the theoretical basis for the development of an organizational model for command and control. Once this foundation is laid, specific relationships to military tactical operations will be delineated, leading to the formulation of the author's concept of organizational control in a combat environment, which is called the Balanced Concept. This model will be examined in the light of naval battle group operations, in an attempt to give specific examples of its potential

contribution to the body of work presently available in command and control theory.

A. BACKGROUND

Throughout history, the function of command has become an increasingly more complex part of a nation's warfighting capability. In the early history of combat, a commander's place was at the head of a massed body, leading it into the fray. In the present and future, the commander sits among a maze of electronic sensory and communications equipment, controlling forces spread over many hundreds of miles. From those early beginnings to the present, command and control has undergone constant metamorphoses, and will continue to do so. In examining the history of command in war, Martin van Creveld [Ref. 2: pp. 1-2] attributes the growth of the C2 problem to five interrelated factors:

1. Increased demands on the systems
2. Advances in technology which multiplied the means available for command and control systems
3. Changes in command processes due to the first two factors
4. Advances in weapons technology which have increased the vulnerability of command systems
5. The rise in cost due to all of the above factors

To the last two factors can be attributed the general trend of command and control in the United States over the past forty years. The economic influence has meant that the balance of the defense budget in the United States has been spent on weapons and delivery systems rather than the command systems to coordinate and improve their use. The influence of the weapons systems themselves is apparent in the increase in the size of the battlefield that superior accuracy and ranges produce. But there is an event of greater significance which has shaped the general trend of thought in command and control since the end of World War II--the detonation of the atomic bomb and the development of a nuclear strategy.

B. EFFECTS OF THE NUCLEAR AGE

In examining modern command and control at both the strategic and and tactical levels, one is immediately confronted by the problem of control and flexibility in a nuclear society. First, there must be sufficient control over the armed forces to prevent any action that might lead to a nuclear war, particularly limiting the possibility of a nuclear detonation. Simultaneously, there must be the flexibility in the force structure to meet a threat at any time or place in the world.

The fear of nuclear war has been a hallmark of work in the field of command and control in the last forty years. In order to deter the enemy from threatening the United States, a workable but economically feasible solution had to be developed. Generally speaking, the bomb was cheaper than a large conventional armed force. Unfortunately, reliance on a nuclear solution was a two-edged sword--the detonation of nuclear weapons could be as detrimental to the user, in the long run, as to the enemy. For this reason, the first emphasis in post-World War II command and control was to restrict the use of these weapons by providing a means whereby the appropriate orders would be centralized in the hands of the National Command Authority, yet issued in a timely fashion.

This orientation towards centralized, downward control at the strategic level, combined with recent perceptions concerning political accountability and the lack of authentic tactical command experience available during the past twenty-five years, appears to have led to an emphasis on the development of technology to provide the same type of centralization at the tactical level. In the author's opinion, it is in tactical warfare that the conflict between flexibility and control truly begins.

C. CONTROL VS. FLEXIBILITY

In order to design a command and control system for tactical use, the characteristics of tactical-level warfare should be examined to provide a framework within which the system must operate. Though this conflict will be analyzed in more detail at a later point in this thesis, some general statements can be made at this point. In the author's opinion, tactical-level warfare is characterized by the following:

1. An increasingly shortened time between events as the operation progresses
2. An increase over time in the level of variety of events
3. A high level of confusion, due to an increase in information reporting combined with a decrease in information content
4. Communications breakdowns resulting from damage and/or interference
5. Alterations of the original plan of action, caused by damage to the force, new estimates and intelligence, and/or inadequacy of the plan.

From this it can be seen that the force and its command and control system must have sufficient flexibility to respond to its changing environment and provide alternative control methods to meet its changing needs. In other words, the system should eliminate the apparent conflict between flexibility and control and provide flexibility of control. A brief review of past development indicates that previous C2 design, with its emphasis on centralized control, has concentrated primarily on the technological, or hardware, aspects of development. But as van Creveld points out [Ref. 2: p. 262], command systems consist of organizations and procedures as well as the technical means.

In this thesis the author intends to provide a new orientation towards the development of command and control systems, by using an organizational approach to the study of control. Command is a process that operates within an organization or force structure, and there is more than one

method available for control of that structure. By examining the most serious problems facing C2 today and defining the situation in which it must function, some new possibilities for solutions may be obtained by the organizational approach.

A number of different models have been developed to define the problem of control at all levels. Major George Orr [Ref. 3] dicusses some of these in his examination of combat operations C3I (see Figures 1.1 - 1.3). Each model, from Boyd's O-O-D-A loop to Orr's Conceptual Combat Operations Process model, can be roughly generalized as consisting of information input, processing of the information, decision-making by the commander based on that information, and communication of the decision to the forces that will implement it. In these models, the decision-making function could be considered to be internal to the commander and the implementation function considered internal to the assigned forces. Looked at in this fashion, the potential areas for distortion, bottlenecks or breakdowns in the system appear to be in the information gathering/processing function and the communication function. In fact, the goal of present C2 research and system development, when viewed in the context of the previously mentioned models, has been concentrated on these two problem areas. What should be pointed out here, is that these models are what will be called static--they divorce the decision-making process from the context of the battle--and, in addition, are oriented towards a centralized, directly controlled concept. For the moment, however, a discussion of the problems in the information and communication functions are apropos.

D. THE PROBLEM OF INFORMATION

As Bernard Bass has observed [Ref. 4: p. 62], effective decisions depend on the quantity and quality of available

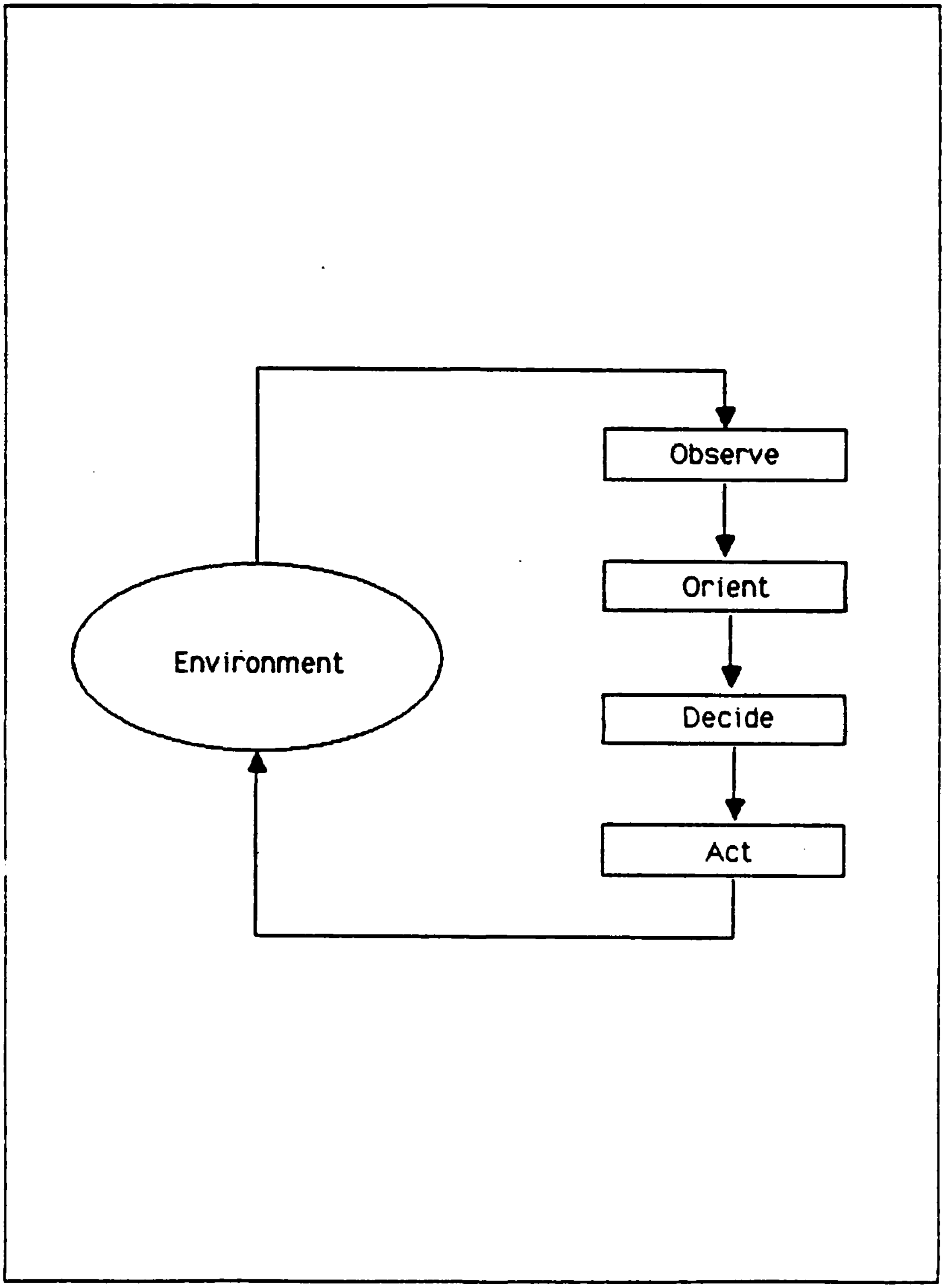


Figure 1.1 Boyd's O-O-D-A Loop.

information. The advent of the computer age has certainly enhanced our ability to collect information, but as van Creveld states [Ref. 2: p. 3], the explosion in data collection has increased the difficulty of interpreting it for use in decision-making. Specifically,

> The more the available information, however, the longer the time needed to process it, and the greater the danger of failing to distinguish between the relevant and the irrelevant, the important and the unimportant, the reliable and the unreliable, the true and the false. [Ref. 2: p. 276]

The study of information in organizational decision-making has led to a number of discoveries concerning its treatment and interpretation. Doctor Bass mentions three specific conclusions [Ref. 4: pp. 62-65]. First, much information may be irrelevant to the decision. Second, many times the decision has been made or a number of assumptions arrived at prior to the search. In this case, the information sought is either interpreted in accordance with the decision or assumptions, or is sought specifically to support them. Last, people see and hear what they expect to see and hear; they tend to classify information according to stereotypes. More clearly, past information or past experience will color the view of the new data--it may be misperceived as "more of the same."

Van Creveld describes these phenomena as what could be paraphrased as the "99 and 1 percents." [Ref. 2: p. 7] In practice, most information is of inconsistent value. The 99 percent of it may disappear without trace, due to equipment failures, loss or other breakdowns of the system, whereas the remaining 1 percent may affect operations profoundly. In fact, the 1 percent may or, more importantly, may not be of value without the other 99 percent.

Finally, there is the effect of time on the value of information. This is a two-fold problem. The problem of

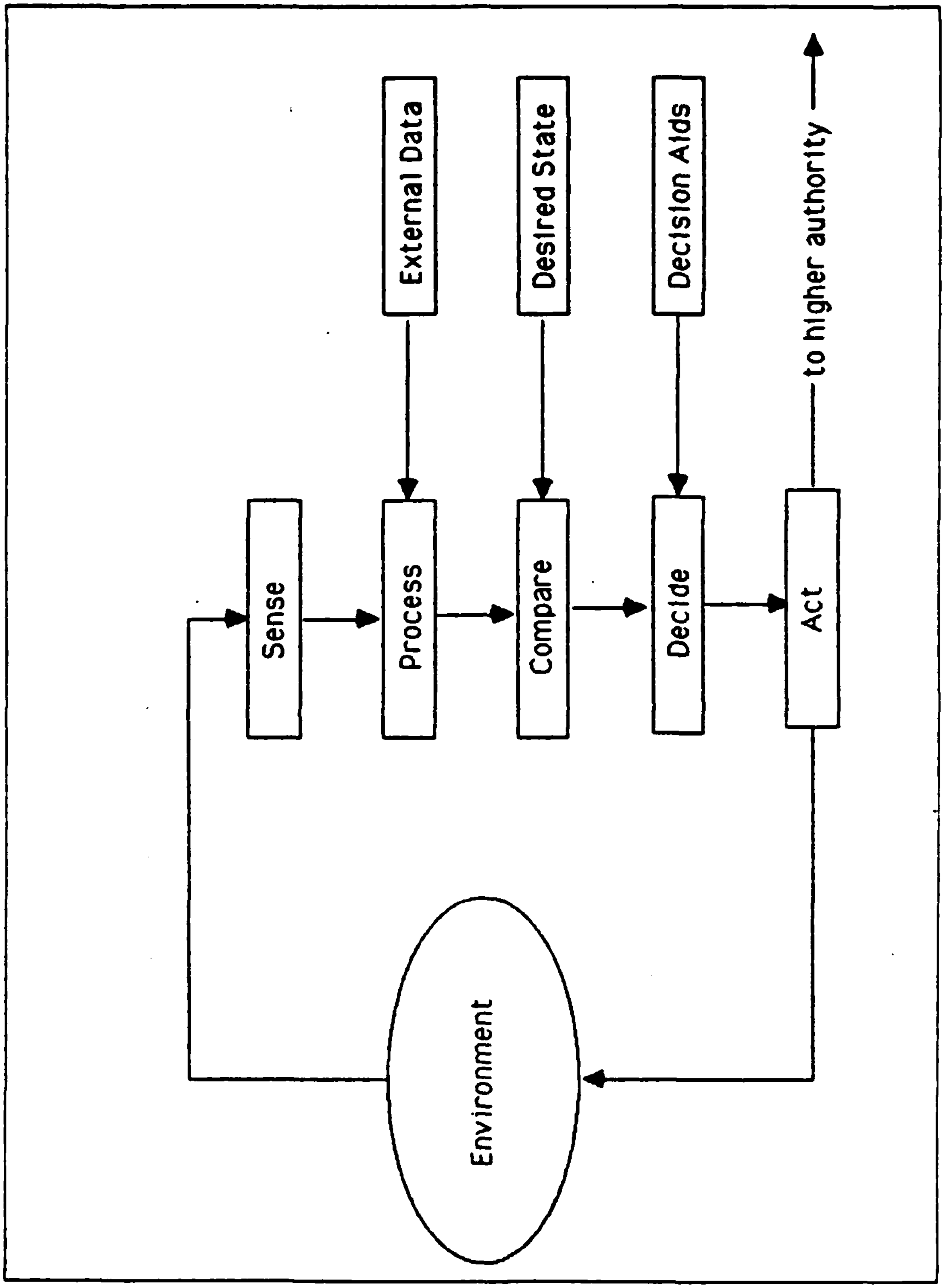


Figure 1.2   Lawson's Combat Process Model.

delay in the reception of data may mean that a decision is based upon old, no longer accurate information. By the same token, when data is coming in at a rapid pace, and the average time between events is shortened, the receipt of information may outstrip the decision-maker's ability to digest it and make a rational decision. In fact, as Bass discusses [Ref. 4: p. 63], a series of simulated complex military decision experiments conducted by Streufert in 1978 found that information received as rarely as every six minutes or as frequently as every two resulted in a significantly lower quality of decision-making. The optimum time between receptions was found to be, on the average, every three minutes.

E. THE PROBLEM OF COMMUNICATIONS

Related to information gathering and processing, because it is the means whereby much of the information is obtained, are the difficulties of communications. This is frequently viewed as a technical problem, and it is in that sense that it will be examined here.

First of all, increasing use of the electromagnetic spectrum for communications and sensor operation has been the source of the growing field of electronic warfare. New, modern combat systems place greater reliance on electromagnetic superiority. Electromagnetic emissions and signatures facilitate location and identification of the enemy, while jamming and other methods of electronic warfare may degrade or prevent the use of communications and sensor equipment [Ref. 5]. During combat, conventional damage to electrical systems, antennae, connecting wire, or entire electronic units or compartments may also result in serious deterioration or loss of communication between the commander and his forces.

In nuclear warfare, whether strategic or tactical, there is the additional possibility of impairment to

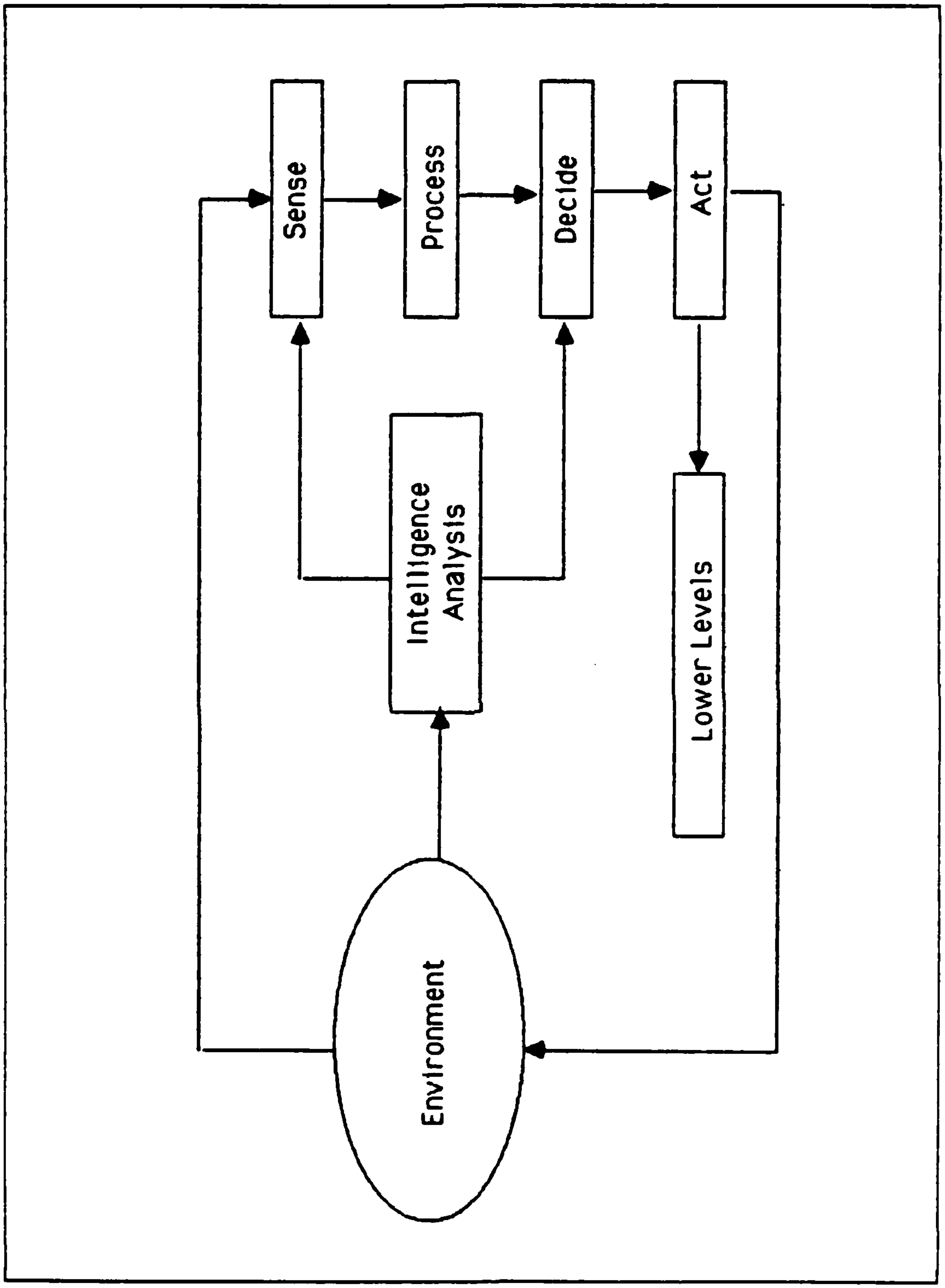


Figure 1.3 Conceptual Combat Operations Process Model.

communications occuring through ionizing radiation. Joseph Rotblat [Ref. 6: pp. 18-19] has discussed the intense ionization of the air caused by radiation, one consequence of which is a short, powerful pulse of electromagnetic radiation, similar to radio waves, but with an amplitude millions of times stronger and covering a continuous spectrum of wavelengths. This pulse may interfere with and cause surges and permanent damage to electrical equipment, particularly solid state devices. According to Samuel Glasstone [Ref. 7: pp. 502,506], there are two principal effects of a nuclear explosion: the electromagnetic pulse (EMP) itself, and disturbance of electromagnetic waves, such as those used in communications and sensor equipment, through alterations to the electrical properties of the atmosphere. The electromagnetic wave disturbance may cause a blackout of radio, radar and related systems for several hours. A general description of the effect of the disruption is that the density of electrons in the air is greatly increased, affecting electromagnetic signals in two ways. First, under suitable conditions, energy can be removed from the wave, resulting in an attenuated signal and, second, a wavefront traveling from one area to another will be refracted--in other words, its direction of propagation will be changed. Thus a nuclear explosion affects command and control through the communications and sensor systems that form part of the C2 network.

F. CONCLUSIONS

As has been discussed, during the past forty years, command and control development has been concentrated on producing centralized systems, heavily dependent upon sophisticated technology. As control of strategic nuclear systems was the paramount goal of early work in the field, this emphasis is neither surprising nor inappropriate. However, as the field of study broadened to include tactical

systems, concepts for command and control do not appear to have expanded commensurately. Though organizational structures, such as the Navy's Combined Warfare Concept, have been designed with the problems of tactical warfare in mind, is the author's opinion that most systems development has continued to search for technological solutions to the problems of information and communication.

Unfortunately, as van Creveld puts it,

> Present day military forces, for all the imposing array of electronic gadgetry at their disposal, give no evidence whatsoever of being one whit more capable of dealing with the information needed for the command process than were their predecessors a century or even a millenium ago. [Ref. 2: p. 265]

He continues, averring that technology is merely one part of the general environment of command; to allow it to dictate its structure and functioning is to become the slave of technology and, moreover, to lose sight of what command truly is. His recommendation, with which the author concurs, is that one must recognize the limitations of "state of the art" and discover ways, specifically in training, doctrine and organization, of compensating for those limitations. In brief, one must, "instead of confining one's actions to what available technology can do, . . . understand what it cannot do and then proceed to do it nevertheless." [Ref. 2: p. 275]

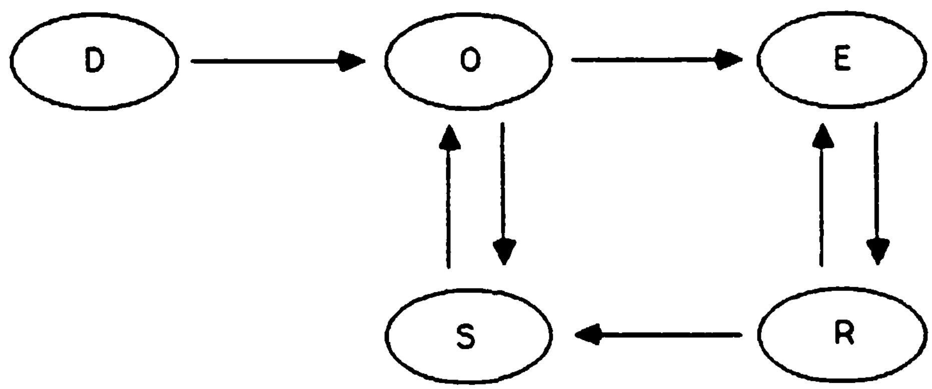
II. VARIETY IN WARFARE

A. ASHBY AND REQUISITE VARIETY

To begin an analysis of tactical warfare, one must deal with what is frequently termed the fog, or the uncertainty, of combat. It is the author's contention that this uncertainty is the result of the variety of warfare, some of the elements of which will be detailed at a later point in this paper. Before beginning such a discussion, a framework for dealing with variety is in order. One such framework may be found in cybernetic, or control, theory.

W.R. Ashby first postulated the law of requisite variety in his An Introduction to Cybernetics. First, he defines a system as a list of variables, rather than as a thing [Ref. 8: p. 40]. An example of a system such as that defined by Ashby, to which the following paragraph may be related, is depicted in Figure 2.1. This loop, developed by Defense Systems, Incorporated for the Defense Communications Agency [Ref. 9: p. 2-14], is called the Adaptive Control Loop.

In general, Ashby characterizes two forces acting on a system as the variables R, the regulator, and D, the disturbance. If R's action or move is unvarying, whatever D's action, then the number of different outcomes, O, of these two actions will be only as large as the variety in D's moves. In this case, D exerts full control over the situation. If R next uses, or has available, two moves, then the variety of the outcomes can be reduced to a half (but not lower). Specifically, "this is the law of requisite variety . . . only variety in R can force down the variety due to D; only variety can destroy variety." [Ref. 8: pp. 206-207] In a large system, such as combat, where there may be a large number of separate causes of



D - Disturbance
S - System
O - Outcome
R - Regulator
E- Evaluator

Figure 2.1 The Adaptive Control Loop.

disturbance (or D's), the main cause of difficulty is the variety in each of those disturbances that must be regulated against [Ref. 8: pp. 244-245].

Although Ashby used this theory within his framework for design of machines to simulate biological systems, it was Burton who applied it to the study of organizational planning [Ref. 10]. Burton characterized present U.S. organizational planning systems as using the problem-solving approach: attempting to forecast the future environment, and making plans within the context of that forecast. A central issue of Burton's approach is the ability, or lack thereof, to predict the future environment sufficiently well to develop an effective plan for implementation. He recommends use of a control approach, resting upon implications from Ashby's law of requisite variety, as a supplement to the development of a single strategy or plan of action.

Put in terms similar to Ashby's, if the level of variety in the environment is large, the organization must ensure at least a matching level of variety in future planning. A single plan of action leaves the outcome completely a function of variety in the environment. If the organization desires greater control over the outcome of its actions, the variety in its potential actions must be increased. As Burton states, this planned variety must exceed environmental variety in order to ensure long-run organizational viability.

By adopting what Burton calls a "flexible configuration strategy", or determining how to configure organizational resources to effectively respond to variety in the future, the organization becomes more flexible in what it can do; it can adopt a large set, or umbrella, of alternative potential activities. More simply, the organization not only has a plan for what it will do, based on its forecast of the future, it has also planned for contingencies when its

forecast is found to be wrong. According to Burton, the elements in the organization that include possible avenues for developing a flexible configuration strategy are:

1. Production processes.
2. Capabilities of individuals at all levels.
3. Organizational inputs.
4. Organizational structure, including variations.
5. Organizational outputs.

Providing flexibility in any, or all, of these areas can provide the additional flexibility of response in dealing with a variable environment. It should be pointed out here, in light of what has been averred concerning the development of command and control systems, that technology should be included in only one of these categories--that of production processes. Already there is the potential for other methods of approach to the solution of command and control problems. First, however, some specific sources of variety and applications of the control approach to warfare should be examined.

B. VARIETY IN THE THREAT

When planning for variety in warfare, the commander should first examine the probable intentions and actions of his adversary. There are a number of factors that may influence what the opposing commander(s) may do. First of all, what may be the mission, or missions, the enemy may be attempting to accomplish? To determine the enemy's most likely objective, the commander must make use of all available intelligence to determine the overall goals of the enemy in making war, and what intermediate objectives will increase the likelihood of his achieving them. It is at this point that the possible make-up of the opposing force comes into play: what assets does the enemy have available to him, and how do they affect his possible choice of intermediate objectives? Some missions may be infeasible

given a lack of or inadequate distribution of resources, or poor training in a specific area. Also to be considered are the possible cultural influences acting on the commander or his forces; for example, is he more accustomed to close supervision and limited initiative, or is he given a high level of independence of action? If the first case is true, he may choose actions which provide more protection for his communications systems; if the second, his range of alternative objectives may be wider, requiring less rear support and communications. An examination of his operating procedures, both from intelligence and past observation can also be a method of determining possible enemy intentions; e.g., if an increase in activity on a particular radio net has preceded certain behaviors in the past, its reappearance could be a indicator for similar actions in the future.

In general, examining an enemy's overall objectives, assets, operating procedures, and cultural orientation may give the commander clues as to the actions he is most likely to pursue. At the same time, the commander must question the intelligence that gives him this perspective on his adversary: is it sufficient, is it reliable, is it accurate, is it correctly interpreted, and does it take into account information which may be contradictory? This "examination of conscience" should take place intensively during planning and preparatory stages of tactical operations, continuing in a less broad form as the operation progresses. It's value is the perspective it gives on the variety of feasible and probable actions on the part of the enemy, one of the disturbance factors in this case.

There are other disturbance factors that can influence both the threat and the force; this could include the geography of the area of conflict (e.g., chokepoint or open ocean, shallow or deep), international factors (presence of hostile or friendly allies, and neutrals), and weather and

oceanographic considerations (electromagnetic propagation influences, storm damage, thermal layers for submarines). These may also exert some influence over the options available to the enemy, and commensurately must affect the commander's plans for variety.

C. VARIETY IN THE FORCE

Once the probable sources of variety in the enemy and other disturbance variables is determined, the force commander can begin to plan his organization or procedures to counteract the possible disruptions to his overall plan of action. It should be emphasized here that this approach does not eliminate the generation of a central plan: it merely, provides for contingencies in case the plan is based upon incorrect intelligence or assumptions, or unforeseen circumstances preclude following it exactly or in its entirety. Planning for variety is a complementary function to the standard planning procedures; it gives planned flexibility to the force.

In applying the control approach to his own actions, the force commander looks at himself in much the same way he looks at his opponent. He knows his missions and objectives. He must also examine the cultural environment of the force and determine what are its strengths and its weaknesses. Does it provide a means for countering variety in enemy actions? His assets must be accounted for and choices made for optimum distribution against a variety of threats; in a fleet scenario this includes the possibility of air, surface, or subsurface action. The effect of socio-political factors is an area which has come to the fore since the Vietnam conflict: is the atmosphere such that certain actions are closed to him because they will cost him political and moral support his force will need to continue the conflict to a successful conclusion? Is his force organized so that it will support his plan and are his

troops sufficiently trained or experienced to meet the anticipated threat? Are his operating procedures well-known to the enemy? A variation in them may confuse his opponent or, worse, confuse his troops. Does doctrine, as it is understood by his subordinates, cover the contingencies that may develop in this operation?

Not only must the commander consider these questions from his own point of view, he must also consider them from that of his adversary. In this self-examination he may identify weaknesses of his own that the enemy may find to be exploitable, and he must develop methods of protection or compensation for them. Locating his own weaknesses may provide clues concerning the optimal targets at which an enemy may choose to strike.

Once he has determined the most likely sources for disturbance from all the D factors to be encountered in the future, the commander may consider their effect on his force. For example, if the probability for a storm is high, he may have to consider the damage it might have on the force, where his maneuvers to avoid it may take him relative to the enemy, and what actions should be taken if any of his units are separated. Similar questions should be raised concerning circumstances occuring during combat that are the result of enemy action. Here, the theory of requisite variety may be used in finding solutions to specific problems, which may come from more than one source. In this case, it may be applied to the problems of command and control.

D. VARIETY IN COMMAND AND CONTROL

In view of the theory of requisite variety, present C2 systems should be examined in terms of their possibilities for failure, and the probable causes of those failures. A previously cited example is that of communications: its loss or degradation may be due to factors such as jamming or

damage from battle or the environment. The question for the commander, or for those that design the systems he will use, is whether the system can withstand these disturbances or, if not, is there a backup or alternative method available when communications are lost. In looking for this alternative, methods other than the technological must be considered, for battle damage to one receiver or transmitter generally means damage to several others, or to entire systems. What should be looked for is other, organizational, methods of control, that can "take over" when the technical systems fail.

In view of Ashby's work, it can be inferred that there are other methods of control that do not necessarily rely on hardware for their implementation. As has already been stated, Burton recommends examining other elements besides production processes (which itself includes more than hardware) for the necessary variety of response; he includes also individual capabilities, inputs, outputs, and organizational structure as possible sources. It is interesting to discover that Burton's five elements have a rough correspondence with five organizational methods of control and coordination, as identified by Henry Mintzberg. The next chapter discusses Mintzberg's concept of control and coordination.

III. MINTZBERG'S APPROACH TO CONTROL/COORDINATION

A. ORGANIZATIONS AND CONTROL

According to Mintzberg, every organized activity has two fundamental and opposing requirements: a division of labor in tasks small enough to be handled, and the coordination of those tasks to accomplish the overall purpose. He defines the organization's structure as "the sum total of the ways in which it divides its labor into distinct tasks and then achieves coordination among them." [Ref. 11: p. 2] The means of coordination are called coordinating mechanisms, which Mintzberg notes as being concerned with control and communication as well as with coordination. In his observations of organizations, he has identified five of these fundamental mechanisms of coordination: direct supervision, mutual adjustment, standardization of work processes, standardization of work outputs and standardization of worker skills [Ref. 11: p. 3]. Each of these will be defined in their simplest application, and in their progressive use within a growing organization.

According to Mintzberg, the simplest method of coordination is mutual adjustment. It is achieved by the process of informal communication. On its own, it is used in the most basic of organizations; Mintzberg uses the example of a few people in a pottery studio. He points out, however, that it is also used in the most complicated of organizations, where the means to the end is uncertain and knowledge develops as the work unfolds; an example here would be a research and development laboratory.

When the number of people in an organization grows beyond what mutual adjustment alone can handle, it turns toward the mechanism of direct supervision. Here one individual in a unit takes responsibility for the work of

the others, issuing instructions and monitoring actions. In these terms, the instructions are specific as to the actions to be carried out as, for example, when the plays are called in a football game.

The next three levels of coordination are characterized by some form of standardization. In effect, the coordination is achieved by some form of training or planning, at a level determined before the work is begun. In its most rigid interpretation, work may continue without supervision or mutual adjustment. The three basic forms of standardization are in work processes, work outputs, or work inputs (referred to as the skills and knowledge of the people doing the work). In each case, the work done must meet predetermined standards.

Standardization of work processes exists when the work content is specified. The value of this method of coordination is particularly evident from Perrow's work in information system analysis [Ref. 12: p. 82]. Perrow described two aspects of tasks: variability and coping difficulty. Variability refers to exceptions from the routine, and ranges from few to many exceptions. Coping difficulty refers to the amount of search required to find a successful response to a situation, and is measured from low to high. As shown in Figure 3.1, the solution to a high level of coping difficulty is to routinize, or standardize, as many operations as possible. Standardization of operations, then, offers a means of reducing coping difficulty.

Assembly line production, as defined in industrial engineering, is an example of process standardization. Instructions on what to do are very specific, and are carried out repetitively. This requires little supervision (only as a check) and no informal communication relating to the work process. Where this method is used, it may be more

		TASK VARIABILITY	
		Few Exceptions	Many Exceptions
TASK COPING DIFFICULTY	High	nonroutine search operations	nonroutine operations
	Low	routine operations	routine search operations

Figure 3.1 Degrees of Task Routine.

or less specific, depending upon the job at hand; e.g., a purchasing agent may have leeway on the level of bids he can make, within a range of prices.

Outputs are standardized when the results of the work are specified. The results must meet certain required minimum and/or maximum standards, such as product dimensions or performance. Mintzberg uses the example of a potter producing pots of a particular size and shape. In this case, the product of one unit, which may be the inputs of another, are always such that they will "fit in" perfectly for any further work: the wedger prepares four pound lumps of clay that the potter knows will be correct for a certain size pot.

There are times when neither the work nor its outputs may be standardized: Mintzberg quotes the context of colonial empires, which can be applied to almost any administrative task with workers separated by distance. Direct supervision may be impeded by lack of sufficient communications and the work and its outputs are not amenable to standardization. The solution is to standardize the worker rather than the work: to specify the level of skill or training required to perform the work. Other examples of this method are the actions of doctors, pilots and computer operators. In this case, the workers need hardly communicate; they know from training what to expect from each other, and their knowledge and skill take care of most of the coordination.

B. THE COORDINATION CONTINUUM

Mintzberg concludes his discussion by stating that the five coordinating mechanisms tend to fall into a rough order or continuum, shown in Figure 3.2.

> As organizational work becomes more complicated, the favored means of coordination seems to shift, . . . from mutual adjustment to direct supervision to standardization preferably of work processes, otherwise

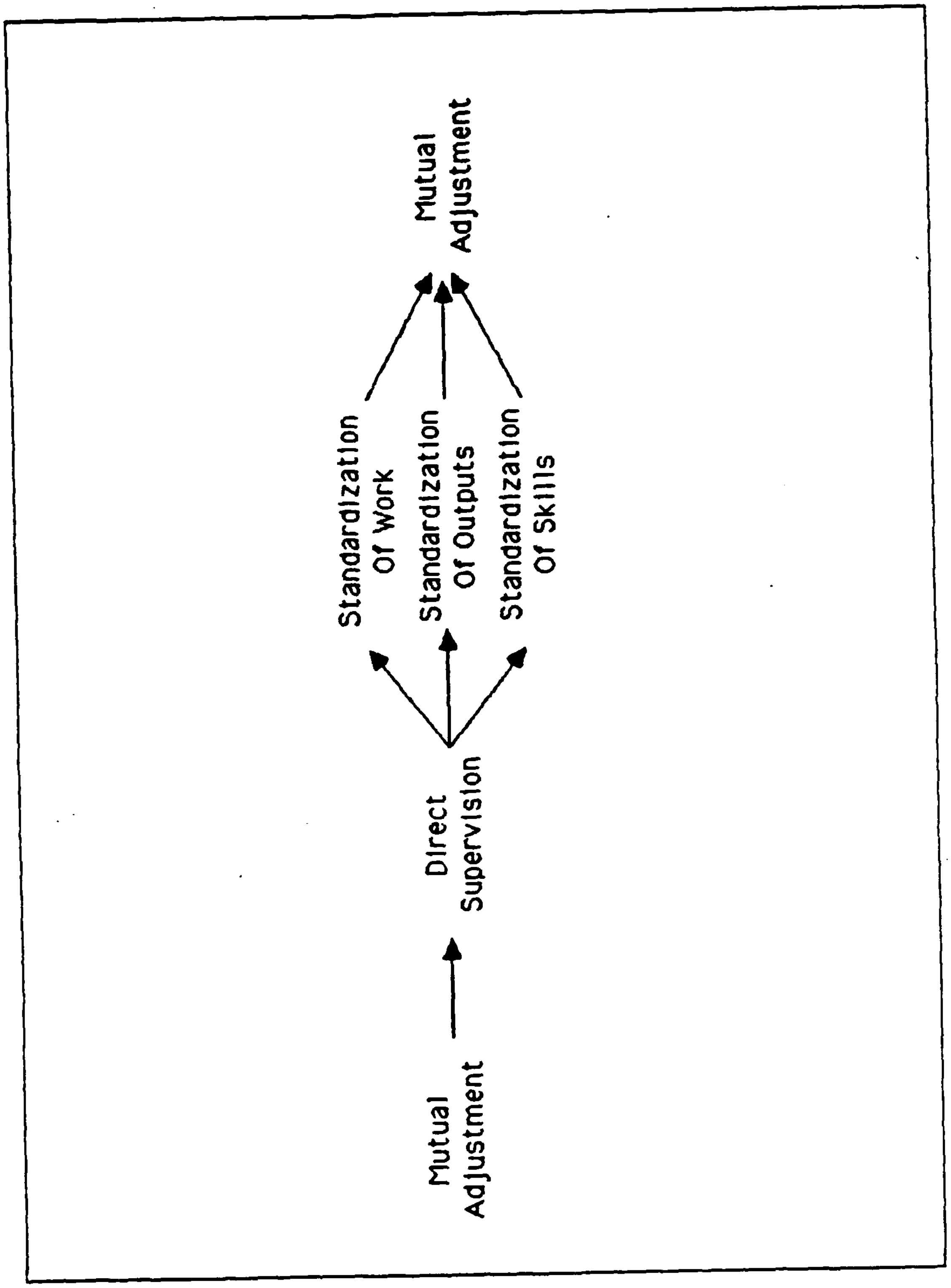


Figure 3.2 The Coordination Continuum.

of outputs, or else of skills, finally reverting back to mutual adjustment. [Ref. 11: p. 7]

In general, small groups of people adapt to each other informally; their means of coordination "across brains" involves some form of mutual adjustment. As the group grows larger, informal coordination becomes more difficult, if not impossible; Mintzberg cites the work of Miller in 1959 [Ref. 11: p. 7], where his observations of coal mining groups showed that with as many as 41 people, miners were able to maintain effective operations on an informal basis. Beyond that number, or with more specific task assignments, direct supervision became necessary due to a decline in system efficiency. The need for leadership moves control of the group to a single individual.

As the complexity of work continues to evolve, control of work shifts to one of the three forms of standardization. Where tasks are simple and routine, the work processes themselves may be the optimum form of standardization. More complex work may require that the outputs be specified, with the choice of process left up to the worker. In many cases, however, outputs are too complex or ambiguous to be subject to specifications; in this event, the organization must settle for standardizing the workers' skills.

Unfortunately, there are some tasks in a large organization that may prove too complex for any form of standardization: this usually results in a return to the first method of control, mutual adjustment. As Mintzberg points out [Ref. 11: p. 8], "sophisticated problem solvers facing extremely complicated situations must communicate informally if they are to accomplish their work."

C. THE COORDINATION MIX

The previous discussion should not imply that an organization will use only one coordinating mechanism at a

time. In fact, most use a mix of all five. Nearly all modern organizations have some form of leadership (direct supervision) and informal communications (mutual adjustment), usually in order to compensate for the problems arising in the use of standardization. The most automated of work places have contingencies which must be dealt with: Mintzberg cites the studies done by Wren in 1967, where a fully automated electric system lacked an effective override, resulting in the northeastern blackout of 1965 [Ref. 11: p. 8].

As Mintzberg summarizes, most organizations of any size make use of standardization where possible, supplementing with direct supervision or mutual adjustment where necessary. When direct supervision is not sufficient (*e.g.*, when coordination is too complex for one individual), the organization will turn to mutual coordination. In contrast, when mutual adjustment cannot solve the problem, due to disagreement or other problems, direct supervision can be used [Ref. 11: pp. 2-9].

IV. MINTZBERG'S METHODS IN MILITARY APPLICATIONS

Mintzberg's five coordinating mechanisms, as previously described, would appear superficially to have more application to civil, business or industrial applications. The present need is for identification of those mechanisms with forms that can be used in a military context. Direct supervision is, of course, readily identifiable; it is the issuing of more or less specific orders from a superior to a subordinate. Mutual adjustment or, as it will be referred to here, mutual coordination, is a multi-layered phenomenon. It may occur between commanders in a large-scale situation, or at the lowest level of rank and responsibility. Output standardization is the specification of the mission or objectives of an operation or assignment. Standardization of process is a more multi-dimensional mechanism; it is achieved through standard operating procedures (SOP's), operation plans, or through operator training. Standardization of skills translates into training also, but at a higher level--training in doctrine. Each of these mechanisms will now be examined and defined in more detail.

A. DIRECT SUPERVISION

As previously stated, direct supervision involves the issuing of orders by a superior to a subordinate. Like mutual coordination, it is multi-layered; e.g., in a Battle Group it occurs between the OTC (Officer in Tactical Command) and his subordinate warfare commanders, and between the Boatswain's Mate of the Watch of an individual ship and his bridge watchstanders. The means of issuance of these orders are varied. They include face-to-face communication, transmission over voice or hard-copy radio or satellite circuits, written directives or memoranda, or visual signals such as semaphore, signal flags or flashing light.

It is direct supervision in one form or another that has been most generally used in the design of models for command and control theory. Boyd's O-O-D-A Loop and Lawson's Combat Process Model, previously mentioned, both include a Direct function somewhere in their feedback loops. In using these models, which are accurate within certain boundaries, command and control for Battle Group operations has tended to focus more on the development of command systems which facilitate direct communications and control between the OTC and his subordinates, resulting in an emphasis on more and more sophisticated communications and information processing systems. These systems are increasingly more complex to operate and maintain, and are more costly to develop and install. They also, in the author's opinion, have another drawback. In any communications or information system encountered by author or her contemporaries, the amount of message traffic or data transmitted via the net or network has always expanded to meet and, eventually, exceed the capability of the system to handle it. The results are delays between transmission and reception, loss of traffic or data due to the sometimes vast amount of material sent and/or received, and the concomitant problem of information overload, discussed in Chapter 1.

In a combatant situation, Battle Group systems relying on direct supervision via radio or satellite are particularly vulnerable to the communications problems detailed in Chapter 1, specifically damage to equipment, jamming and interference and, in an exchange of nuclear weapons, the effects of the electromagnetic pulse. Visual communications are inadequate to the purpose, due to the expansion of the naval battlefield which can be attributed to increased ranges of weapons and the necessity of separating units to preserve their viability.

Any attempt to use only the mechanism of direct supervision in naval warfare will also be frustrated by the problems of information delay and/or overload, also previously examined in this thesis. In the author's experiences with exercises and wargames, which themselves are tightly controlled, the amount of information in tactical operations, when acted upon by a single commander, will quickly exceed his ability to comprehend it. This occurs most particularly when the mean time between events (which will be referred to as MTBE) becomes shortened. This MBTE is defined by the author as the average time between occurrences, such as an identification of incoming missiles, a possible submarine detection, the location of a hostile surface action group, or continuing updates on any of these and other tactical developments. Also contributing to the problem is an increase in the level of task variability (LTV), defined by Perrow and described in Chapter 3, which causes an increase in coping difficulty. As the MTBE is reduced and the LTV is increased, a single commander, attempting to deal will all contingencies himself, will lose the "big picture" in the myriad of details being reported to him.

It has, of course, been recognized that a totally centralized structure is inadequate to Battle Group operations. The Combined Warfare Commander concept is designed to distribute responsibility to subordinate commanders, allowing the OTC to retain an overall perspective of the battle and negate or guide the actions of his subordinates. It is also recognized that, within limits, the commanding officer of a vessel has the ultimate responsibility for "fighting his ship" in any conflict. But again, an officer who has experienced refresher training on board a warship will have seen the confusion that can develop when the Training Group "throws everything at" the

crew. In such a situation, the captain and his Tactical Action Officer (TAO) would still be unable to handle every detail of the battle alone. Distributed throughout the Combat Information Center (CIC) are officers and men assigned to handle contingencies within some prescribed limits. It is here that other coordinating mechanisms come into play, each of which will be discussed.

B. MUTUAL COORDINATION

When responsibility for specific warfare tasks within a Battle Group is delegated, mutual coordination is required between those to whom the tasks are assigned. This coordination may be necessary for allocation of resources, such as ships, aircraft, or weapons and sensor systems. It also must be present to prevent accidents; for example, ship collisions or taking friendly aircraft under fire upon their return to the group. On a lower level, when force efforts must be concentrated or when there are overlapping regions of responsibility, such as sectors, coordination between individual ship commanders becomes a must, to prevent both duplication of effort and/or interference. A similar situation exists between aircraft in flight, or individuals aboard a ship who are defending it from attack.

Between commanders of separate Battle Groups, subordinate warfare commanders, and physically separate units, mutual coordination suffers from the some of the same drawbacks of direct supervision. Specifically, such coordination requires communications; between groups or warfare commanders, it will usually require radio or satellite communications. Individual units will also require radio, unless they are close enough to communicate visually, a situation that may not exist due to the expansion of the modern naval battlefield.

The pace of the battle may also degrade the ability of the Battle Group to use mutual coordination. It is the

author's belief that, when the MTBE is shortened and the LTV is increased, the quality of interaction between commanders at all levels is reduced. There is less time for one commander to fully inform another of his intentions, if at all. The natural brevity of the information transmitted may lead to misunderstanding, confusion and interference.

When mutual coordination between commanders or units is required to concentrate forces against a multiple threats, additional problems may develop. When one commander perceives one threat, an incoming air attack for example, to be the paramount threat to the group, he may call for assistance or additional resources. Another commander may not share his concern, believing action against a submarine threat to be more imperative. Mutual coordination alone may not be sufficient to solve the conflict in resource allocation and Battle Group posture. Again, additional methods of control will be required.

C. STANDARDIZATION OF OUTPUT

Standardization of output, as previously defined, is the specification of the mission and/or objectives of an operation. Its use as a method of coordination is based on complete dissemination and understanding of the mission throughout the force. It is also a multi-layered mechanism, as the overall Battle Group mission is supported by the many lesser missions, or more precisely, objectives which are assigned to separate divisions or units of the force.

The assignment of the objectives to members of the force may be made at many different points during the tactical operation. For example, during the planning stage of an operation the missions of anti-submarine warfare, anti-air warfare and anti-surface warfare are assigned by the OTC to specific subordinate commanders. Each commander will be given parameters within which they are to operate, and requirements for contact prosecution based on conditions

such as distance from the force center or the perceived threat axis. The conduct of operations to achieve the objective is up to the individual commander, within the guidelines specified. Similarly, when a Surface Action Group is detached from the main body to intercept and investigate a target or when a reconnaissance flight is launched during the period of actual operations, the objective is defined and certain parameters delineated, within which the commander of the SAG or reconn flight is able to take what action he deems necessary.

The advantage of this mechanism of control becomes apparent in fast-paced situations, where the MTBE begins to shorten. When the individual decision-maker, at whatever level, has received a clear understanding of the mission of the force and his particular portion of it, he may independently take any necessary action called for by the situation, without being called upon to wait for an order given by a single commander who may be overwhelmed by reports and information. This decentralization of command and control is not an unusual notion when examined within reasonable limits. As Van Creveld points out, "there is not a single member in any armed force at any time and place who has not performed some of the functions of command for at least part of the time." [Ref. 2: p. 263] This method of control is, of course, not without its drawbacks.

The problem that exists in the use of standardization of output as it is defined here, is that the commander, at whatever level, may not have the expertise or judgement to make the necessary decisions to achieve the prescribed goal under existing conditions. Additionally, this mechanism rests upon a clear understanding at all levels of the overall force objectives, and each individual's place within the scheme of things. Failure to communicate fully his portion of the mission and its relationship to the whole to

each decision-maker, whether he is the ASW Watch Officer on a frigate or the ASW commander directly subordinate to the OTC, may result in a wrong decision and concomitant interference with others in the Battle Group. Again, this method alone will not solve the problems of command and control in a modern tactical force.

D. STANDARDIZATION OF PROCESS

In the realm of military applications, standardization of process has two applications. In one sense it is training, defined within very specific limits. It is operator training - how to use the equipment and/or tools one is given. It can be multi-layered in the sense that an officer learns how to "drive" a ship and his helmsman learns to control the ship's rudder. It includes use of weapons systems, as in training to operate and read a radar, use a targeting system, or fire a missile. It does not include, however, the training in how to "fight" a ship or aircraft, or a group of ships and aircraft, intelligently. That aspect of training will be discussed at a later point in this thesis.

This is a necessary mechanism in command and control in that when an order is given, for example, to acquire a target and take it under fire, the order need not be so detailed as to include every action on the part of the operator of the weapon systems. The unit commander issuing the order is aware that the operator is sufficiently trained to execute his command in a correct and expeditious fashion. This frees his time for examining other situations and issuing additional orders. As one moves up the command hierarchy, the same type of relationship exists between, for example, the ASUW commander and one of the unit commanders with assets which may be used in an anti-surface role. In this and similar situations, however, the knowledge used by the "operator" has moved into another dimension. There is a

fine line dividing the two, but though both situations involve training, the author feels the more advanced situation has more to do with skill, and therefore has placed it in the area of standardization of skills, in which section it will be discussed.

The second application of standardization of process is in the area of planning. Most members of the military are familiar with the term or title Standard Operating Procedures (SOPs). These are procedures which a command, or group of commands, will execute in cases involving identifiable, well-defined situations or contingencies. They may cover a variety of differing problems. A ship may have SOP's ranging from message distribution, emergency destruction, issuing of emergency leave for crew members, or the proper standing of a bridge watch; an example of the last is the Captain's Standing Orders. Standard procedures also may be incorporated for tactical situations. Within an individual ship, training will have been conducted to inculcate the proper methods of damage control when under attack in order to prevent the spread of damage which may render the ship unable to fight. In the case of carrier aircraft, specific procedures also will have been established for locating the carrier after a mission, making contact and, if necessary, ditching.

In addition to the various SOP's available for guidance in a tactical situation, there are also the plans specific to that operation. Generally, these take the form of operation plans, or OPPLAN's, which may cover a myriad of details such as communications frequencies to be used, contact reporting procedures, emission control requirements, and the rules of engagement. Some portions of the plan may be taken from standard operating procedures which have been adapted to the situation or, where necessary, developed specifically for the operation at hand.

The advantage of this coordination mechanism is that the OTC may be reasonably sure, when communications with his subordinates are degraded or lost, or when he must distribute his authority and responsbility due to information processing problems caused by a reduced MBTE and increased LTV, that his subordinate commanders have the necessary guidelines to fight the battle. The SOP's and/or OPPLAN can, indeed, be specific on what conditions will automatically engender the transfer of authority. In addition, as an aid to mutual coordination, the plan may include a more or less specific listing of actions that the commander has planned for the various units with the approximate times for their execution. In the case of aircraft strikes, this kind of information might prevent incidents such as ships in the group taking returning aircraft under fire before making a careful attempt to identify them. The utility of the operation plan is, of course, increased when it includes the type of varietal planning detailed in Chapter 2 of this thesis. A determination of the likely effects of disruption of command and control, and the resulting confusion, should assist the commander and his staff in planning for C2 contingencies.

The problem with both SOP's and operation plans is that they can never cover the complete range of emergencies that may develop in the course of a tactical operation. They may, of course, provide a frame of reference within which a course of action may be chosen, but by the same token, heavy dependence upon written procedure may also inhibit the military decision-maker from choosing a innovative, yet effective, method which could achieve the desired goal. The question then becomes, how may innovation in command be encouraged, and still ensure a measure of control over the actions of subordinates?

E. STANDARDIZATION OF SKILLS

It is the author's belief that the answer to this question lies in standardization of skills, to be achieved by additional training; specifically, training in what the Navy Command and Control Plan describes as doctrine:

> Doctrine exerts a strong influence in the decision-making task. Doctrine provides operational commanders with decision and action guidelines for response to a range of predictable tactical situations. The importance of these guidelines is indicated in JCS PUB 2: "Common doctrine is essential for mutual understanding and confidence between a commander and his subordinates, and among the subordinates themselves, so that timely and effective action will be taken by all concerned in the absence of specific instructions." [Ref. 13: p. 14]

The formulation of this doctrine is the result of the subjection of decision guidelines and associated tactical responses to extensive development and operational testing. When it is accepted, it becomes the basis for defining training requirements and performance standards for tactical forces. The benefit to the commander is that it provides him with a ready set of proven decision rules, for which his troops are prepared from rehearsals in exercises [Ref. 13: pp. 14-15].

The next question is, how are these rules developed and tested, particularly for modern naval warfare, when this country has not recently been involved in a conflict which required true naval tactics? There are two means available, one of which has been used as extensively as money and time would permit, and the other is just beginning to come to the fore. The first is, of course, naval exercises. The exercise offers the most realistic means of developing doctrine. Unfortunately, it is expensive in terms of the fuel and other operating costs required to put a fleet of ships to sea. In recent years, also, it has been viewed as a less than realistic means of testing tactics, as the

exercise may be so tightly controlled that the effects of combat may not be "permitted to interfere" with the conduct of the operation. One example of this, which has been said to occur not infrequently, is the exercise commander's refusal to allow his communications to be degraded. Under such a restriction, command and control doctrine cannot be tested, nor can new means of control be developed and tested.

The other method is the military wargame. New computer systems have made available games such as NWISS (Naval Warfare Interactive Simulation System) and NAVTAG (Naval Tactical Game), which allow naval officers at all levels of command an opportunity to "fight" different naval scenarios as a means of learning naval tactics and doctrine. Though not truly realistic, more variables in the battle are possible as software improves, allowing realistic restrictions in fuel consumption, communications capability, sensor utilization, and weapons operation. Though the software is expensive, and sometimes laborious to develop, once in place it provides a much less expensive, and more flexible, means of testing doctrine than the fleet exercise. It is also more forgiving, as a mistake in a wargame does not have the permanence of one made in "real life."

F. CONCLUSIONS

Naturally none of these mechanisms alone can provide an answer to the problem of organizational command and control. As was described in Chapter 3, a mix of the coordinating mechanisms is usually necessary in order to provide adequate control, particularly in an organization like the military, which deals with a sometimes extremely dynamic, certainly hostile, environment. How the mix works depends on how the organization is defined along a "time line" of tactical operations. The rest of this thesis will deal with that time line, and with what the author refers to as the Balanced Concept.

V. A SYNTHESIS OF THE CONTROL METHODS FOR FLEET COMMAND

A. THE SIX PHASES OF TACTICAL ACTION

Before an analysis of the tactical application of the five coordinating mechanisms can begin, a generic model of the progress of a tactical operation must be established. Because a tactical operation is evolutionary, the model must include some form of change over time. As mentioned in Chapter 1 of this paper, most command and control models involve a feedback loop of some kind--a static model of the decision-making process. There have been some attempts to modify such models into a time line, as in the [Ref. 14: pp. 5-14, 5-15], but such time lines are just a different method of displaying the loop. These models do not show the evolution of the various conditions under which the decisions may have to be made; in short, they divorce the decision from the situation. What the author hopes to do, is to design a situational model of tactical warfare to which these decision loops, or other models of control and coordination, may be applied.

The author's model is called the Six Phases of Tactical Action, and is similar in structure to a time line, though without specific demarcations or time limits. Specifically, it defines the approximate relationship between six identifiable phases of tactical warfare over time. These phases, with temporal relationships as shown in Figure 5.1, are as follows:

1. Training Phase (made up of both Peacetime and Hostile components)
2. Planning and Preparation Phase
3. Transit Phase
4. Contact Phase
5. High Intensity Phase
6. Resolution and Recovery Phase

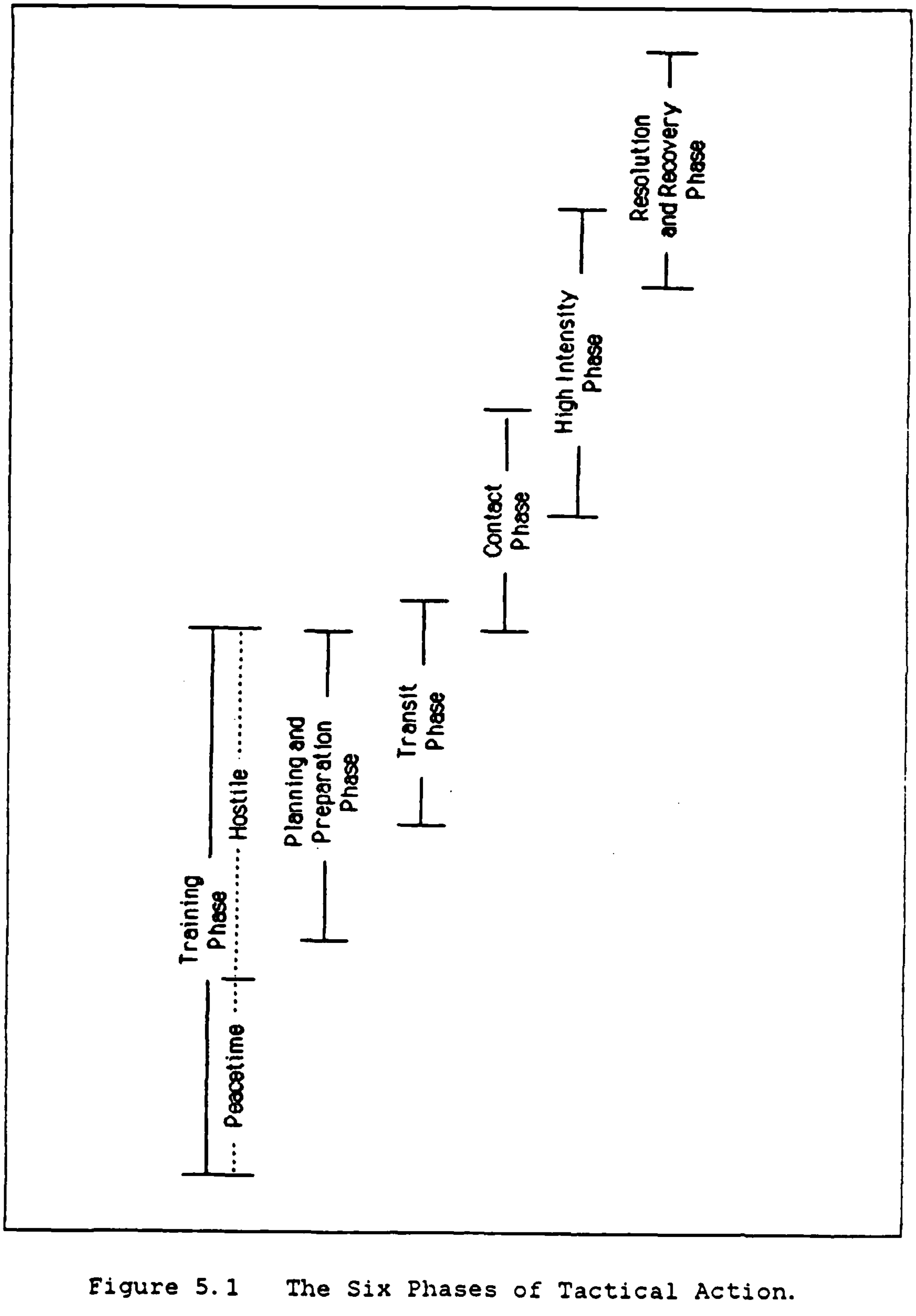


Figure 5.1 The Six Phases of Tactical Action.

What must be emphasized about the diagram, is that no one phase occurs exactly as pictured with relation to another; it occurs approximately at that point along a time line which runs roughly from the inception of an operation to the termination of hostilities. The phases may be seen as forming a loop as a force moves from one operation to the next, or the progression from phase to phase may be interrupted due to one or the other force commanders' decision to withdraw from the battle; for example, if the enemy force commander should withdraw to a more advantageous position, the phase progression could interpreted as Contact Phase--Transit Phase--Contact Phase. It should also be stressed that more than one phase may be occuring simultaneously at two different locations, i.e., in the world, in a force made up of multiple battle groups, or even within a single battle group. For example, the contact phase of ASW action may occur during the resolution and recovery phase of AAW action; yet to the OTC, the overall situation is still in the high intensity phase. In this thesis, the author will be speaking of the model in a general context, occasionally using specific examples to demonstrate its applicability. Discussion of the model will begin with the Training Phase.

B. THE TRAINING PHASE

As previously mentioned, the Training Phase is made up of two separate components, peacetime and hostile. There are some similarities between the two. Both deal with training for new accessions, instruction in equipment use and operation, and education in various methods of tactical or strategic warfare. Their primary differences are in tempo and overall training emphasis.

It can be argued that peacetime training is not truly a part of tactical action, as it is general in nature. The author believes it must be included, as the foundations laid

during peacetime training have far-reaching effects during any period of hostilities; one cannot prepare for war only when it begins. Similarly, training during the hostile phase is not always operation-specific, but in its earlier stages fulfills much the same function as peacetime training, within narrower limits.

The peacetime training component is characterized by general training and readiness. There is no specific opponent, or opponents, in mind as the object of training, though one or more entities may be considered a primary threat. For example, though the United States may presently consider the Soviet Union its primary antagonist during the the present period of relative peace, military training is not restricted to dealing with the USSR alone. It includes preparation for situations involving localized conflicts, terrorist actions, or peace-keeping missions. The tempo of peacetime training is slower, as there are no strategic or reserve mobilization deadlines to be met, and requirements for training of replacements is limited to normal accessions due to discharges or retirements. At the same time, the emphasis on control of costs characteristic of periods of calm usually results in the frequency of certain types of training (such as exercises) or numbers of individuals selected for additional training (an example is specialized schools) is reduced. In general, the emphasis in the peacetime training phase is on readiness for any possible contingency.

In contrast, the hostile component of the training phase is typified by greater urgency and specificity. It may begin with either a declaration of hostilities, as in the case of a localized conflict or anti-terrorist action, or with a general buildup of tensions, where an opponent and his allies become progressively more open with their hostile intent. In either case, a specific range of opponents is

identified, along with the probable geography of hostilities. Training becomes concentrated on actions and techniques which may be employed by or upon the antagonist; briefly, one comes to "know one's enemy" and how best to fight him. The tempo of training steps up as any necessary mobilization of reserve forces begins, and as specific strategic objectives are set, training for operations to achieve those objectives starts. Cost becomes less of a control over training requirements, and if time, security, and available supplies allows, any required exercises or operation rehearsals will be conducted.

It is the hostile training phase that has overlaps with others of the six phases of tactical action, due to the inclusion in this component of training for specific tactical operations. Preparation for an individual naval or land battle continues up to the moment of contact with the enemy; part of that preparation is training. But before any operation-specific training can begin, the strategic and tactical objectives must be chosen, and the plan for goal achievement be made.

C. THE PLANNING AND PREPARATION PHASE

The Planning and Preparation Phase of tactical warfare begins with the selection of a force mission or missions. This could be considered the real starting point of tactical action. In a large-scale operation, it is initiated at a much higher level than that at which it will be carried out, in fact, at the strategic level of command. As planning continues, lower levels of command will progressively become more involved in the selection of objectives or targets, and in operation plan development. During this phase, the mean time between events (or MTBE, as it has previously been defined) is, in most cases, of a duration which allows more thorough examination of alternatives and specific planning. Relative to later phases, the MTBE here is longer than at

any other time. Conversely, the level of task variability (or LTV) should be based upon future expectations, in order to ensure a sufficient number of routine, or standardized, procedures are prepared to deal with the variety of tasks that may be encountered in combat.

It is during this phase that commanders at various levels, and their staffs, produce, select, and/or modify the operations plans, standard operating procedures, and standing orders that will govern the conduct of the operation. They will also be responsible for ensuring that logistics preparations are thorough; for example, is it possible for the force to carry all its supplies, or will sources and locations for resupply have to be selected and prepositioned? The key problem during this period is ensuring that there is full communication among planners within and between the commands and staffs, in order to ensure that the force mission is understood at all levels, that all necessary expertise is brought to bear in order to select alternatives, and that problems of coordination and interoperability are kept to a minimum. In situations involving a large operation, with a high mix of forces, this phase could be the most crucial, and the one in which the greatest mistakes can be made.

The planning and preparation phase will also include any rehearsals or exercises of the plan. If the operation time line permits, such a rehearsal is invaluable in determining possible plan weaknesses and problems of interoperability or coordination that were overlooked by the planning organization. These rehearsals may take place prior to force embarkation, or during transit to the objective area. In either case, the surfacing of significant problems will result in changes to the OPPLAN.

The planning and preparation phase may be considered to continue up until the point of contact with the enemy, as

modifications or updates to a plan may still be issued by the OTC or his subordinate warfare commanders until that time. After enemy contact is established, and the engagement begins, any necessary modifications to a plan are the result of directives for immediate implementation, rather than planned changes.

At some point during the planning and preparation phase, the force will begin movement toward the objective area. This phase is called the transit phase.

D. THE TRANSIT PHASE

The Transit Phase begins with force embarkation and continues until the objective area is reached, or until the enemy is engaged. Contact with or engagement of a single aircraft or scouting ship does not end the transit phase, however. Location and engagement of the more substantial part of the force to which the single unit belongs, however, does constitute the end of the contact phase. This phase is characterized by continuing search operations, minimization of actions which may give away force position, and intensified training in the force mission and plan execution. As emission control (EMCON) is usually enforced to prevent detection of the force due to electromagnetic emissions, communications will be reduced to visual signals and a minimum of, if any, radio signals.

As the force draws closer to the objective area, the MTBE will probably decrease as search operations are increased, and preparations are made for any pre-planned actions. In the case of a carrier air strike, aircraft will be prepared and loaded, aviators will be thoroughly briefed, and ship's personnel will take station for flight operations and prepare for possible retaliatory action. In an amphibious landing, preparations will be made for naval gunfire and air strikes, landing craft will be prepared for launch, surveillance of the landing area will be conducted, and troops will be stationed for craft loading and launch.

The transit phase may begin very slowly, with a very low operations tempo, depending upon the distance of the embarkation point from the expected area of operations. As previously mentioned, it may include modification of the operation plans or, in case of a contingency developing elsewhere in the world, a complete change in the force mission. Generally, it is a period of waiting, when the force begins to build itself to its peak--refining the plan, ensuring readiness for contingencies, training the troops, and looking for the enemy. It can also be a shortened period, particularly when the enemy is in close proximity to the area of embarkation, or positioned in the path to the force objective area. In this case, the MTBE may be reduced abruptly, and the plan modified at its very inception. In either case, the transit period ends with enemy contact.

E. THE CONTACT PHASE

The Contact Phase begins with the first sighting of an enemy contact. The MTBE is immediately shortened, and the LTV increased, as action is taken to subject the contact(s) and the surrounding area to more intense surveillance, take the enemy under fire, or respond to an incoming attack which has been detected, depending upon the nature of the initial contact. The MTBE and the LTV continue their respective downward and upward trends as the detection and identification of further enemy forces continues, and force actions are determined and implemented. The contact phase continues until all, or nearly all, enemy forces are identified, or any additional contacts encountered are not expected to continue the battle. For this reason, the contact phase may sometimes be considered to extend into the period of battle resolution and recovery; the author feels, however, that virtually all hostile forces in the battle area would be identified at a point earlier in the high intensity period of the conflict.

During this phase, EMCON conditions will become progressively more relaxed as hiding force location and preventing unit identification becomes less imperative. Communications and sensor availability will increase, with the exception of radiations which might allow targeting of the high value unit(s), such as the aircraft carrier or other flagships. By the same token, enemy electronic counter measures (ECM) and initial damage to friendly units may begin to degrade the use of electronic equipment even as it becomes available.

It is at this point that the Training and Planning/Preparation phases end, as any "education" gained by personnel during the following activities would come under the category of experience, and any modifications or extensions of operation plans would be the result of immediate evaluation, selection and execution, rather than full analysis, dissemination and testing.

Depending upon the scope of the battle and the relative strengths of the forces engaged, the contact phase could pass almost directly into a period of resolution and recovery. This pre-supposes that one force is overwhelmingly more successful than the other, due to either superior numbers or superior skill. The author contends that such an imbalance is very rarely the case, and that in order to provide a complete model for tactical warfare, the contact phase must pass into a period of high intensity action.

F. THE HIGH INTENSITY PHASE

The High Intensity Phase is so named because of the level of action taking place. In this phase the MTBE is reduced to its lowest level, with the result that there is less time available to spend on information reporting, and subsequent processing of information received is degraded by the shortened time line. By the same token, the LTV peaks,

and the individual commanders, at many levels, begin to experience a decline in their ability to comprehend, and cope with, the battle. Additionally, the use of electronic countermeasures and/or damage from successive attacks begin to severely reduce the communications capability of the force. If tactical nuclear weapons are employed, loss of communications and sensors may be virtually, if not actually, total, due to the effects of radiation and the electromagnetic pulse (EMP).

At the same time, any number of unexpected events, such as loss of assets, underestimation of enemy forces and capabilities, or inaccurate prediction of weather effects, may make it difficult, impossible, or inadvisable for elements of the force to carry out their portion of the mission. In this situation the plan may be altered, and at several possible levels. In a naval scenario, the OTC, one of his subordinate warfare commanders, or any of a number of unit commanders may have to order and/or carry out a deviation from preplanned actions in order to meet an assigned objective. Unfortunately, such alterations may cause further confusion when other members of the force are not informed of the change and are not able to interpret the intended result from any actions they observe their counterparts executing. The probability of mutual interference grows commensurately.

G. THE RESOLUTION AND RECOVERY PHASE

At some point, one or both forces will have begun to lose their capability to continue the battle, due to damage, personnel exhaustion, a reduction in force numbers, and/or a decrease in the choice of actions available. As this occurs, the MTBE lengthens, the ability of the individual commander to comprehend events increases commensurately, and he begins to attempt to re-marshal and re-organize his forces. At this point, the battle moves into the Resolution and Recovery Phase.

The resolution and recovery phase is characterized by a withdrawal from the scene of action by one or both of the opposing forces. Damage assessments are made, and actions are implemented at all levels to repair what can be repaired, compensate for what cannot, and control the further spread of damage. Communications circuits which have been degraded due to ECM, but not lost to battle damage, will be available for the commander's use in obtaining situation reports from the units under his command. As the MTBE increases and the LTV decreases, there is a concurrent increase in the individual commander's ability to process information, will allow the OTC to take direct control of his units as necessary, and give orders for reconnaissance of the opposing force, "mopping up" actions, and/or withdrawal of part or all of his force. The OTC will begin comprehensive reporting to his superiors outside the force, and begin preparations for further operations, if indeed these have not already begun. By this, it can be seen that at or near the completion of the resolution and recovery phase, the tactical process returns to the planning and preparation phase of a new operation.

H. SUMMARY

The effects of the six phases of a tactical operation can be summarized briefly in the following manner. There must be a period of training prior to the initiation of an operation, in order to ensure that each individual is familiar with his equipment, its operation, and its function in warfare. The initiation of an operation begins slowly, with a period of as deliberate and careful planning and preparation as is possible in the time allotted. Once the force is embarked, the transit period begins, with a steady increase in operations tempo which continues through enemy contact and identification, and peaks at some point during the battle, decreasing thereafter as the force begins

reconstitution. As the tempo increases, the volume of information also increases, and the ability of individual commanders to comprehend the battle decreases. As the force approaches the enemy, communications are lost due to the effects of ECM, and continue to be degraded during the battle due to damage to communications equipment.

In the face of these assumptions, the question becomes what methods of control can ensure that the problems of communications degradation and information processing do not prevent the force from achieving its mission. No method is absolute, but it is the author's contention that in order to provide for the variety of problems, a variety of solutions must be built in to the organization. A mixture of the coordinating mechanisms defined in Chapter 4 can provide a measure of flexibility to meet the problems of tactical command and control. This is not to imply that these methods have not been used in the past, but that this thesis will offer a model by which they can be defined and made available for conscious application and analysis. The author calls this model the Balanced Concept.

I. CONTROL DURING THE SIX PHASES--THE BALANCED CONCEPT

The Balanced Concept is based upon the idea that no one mechanism of organizational control is sufficient in an environment as actively hostile as that of a military unit in combat. Additionally, no one method could be considered optimum throughout the progress of a tactical operation which, for the purposes of this thesis, the author has defined as the Six Phases of Tactical Action. The author contends that a mixture of Mintzberg's coordinating mechanisms, defined within a military context, provides a means of "getting around" the limitations of technology as defined in Chapter 1.

The "balance" in the Balanced Concept lies not so much in the use of Mintzberg's mechanisms in combat as in their

availability for use. In other words, the force and its resources must be structured to ensure that all five methods are present so that, when necessary, they may be used in battle. Relating this to Ashby's and Burton's work in variety, a balance in the organization of the five coordinating mechanisms provides the "flexible configuration strategy" which permits the force to respond to the variety of stimuli which may be encountered in combat. Also related to Burton's work as discussed in Chapter 2, the author believes that these methods take into account production processes (OPLANs, SOPs and operator training), individual capabilities (skills), production inputs (defined by the author as the force itself), production outputs (achievement of the mission objectives), and organizational structure (within which the author places direct supervision and mutual coordination). Thus, the organization is configured for variety in its attempt to deal with the contingencies of command and control. A way in which the coordinating mechanisms may be imposed on the six phases of a tactical operation is demonstrated in Figure 5.2.

How and when each method is implemented for use during the operation is a function of the context of the battle, and the level to which each method may contribute to an overall measure of command and control effectiveness. It may also be a function of the force commander's personal style as, in fact, different mixtures of the coordinating mechanisms may produce an equal level of command and control effectiveness in the same tactical situation. The point here is that the effectiveness of any one method should be related to an overall measure of C2 effectiveness. The reader is here referred to such works as the report of the Command and Control Evaluation Workshop [Ref. 14] for material on C2 Measures of Effectiveness.

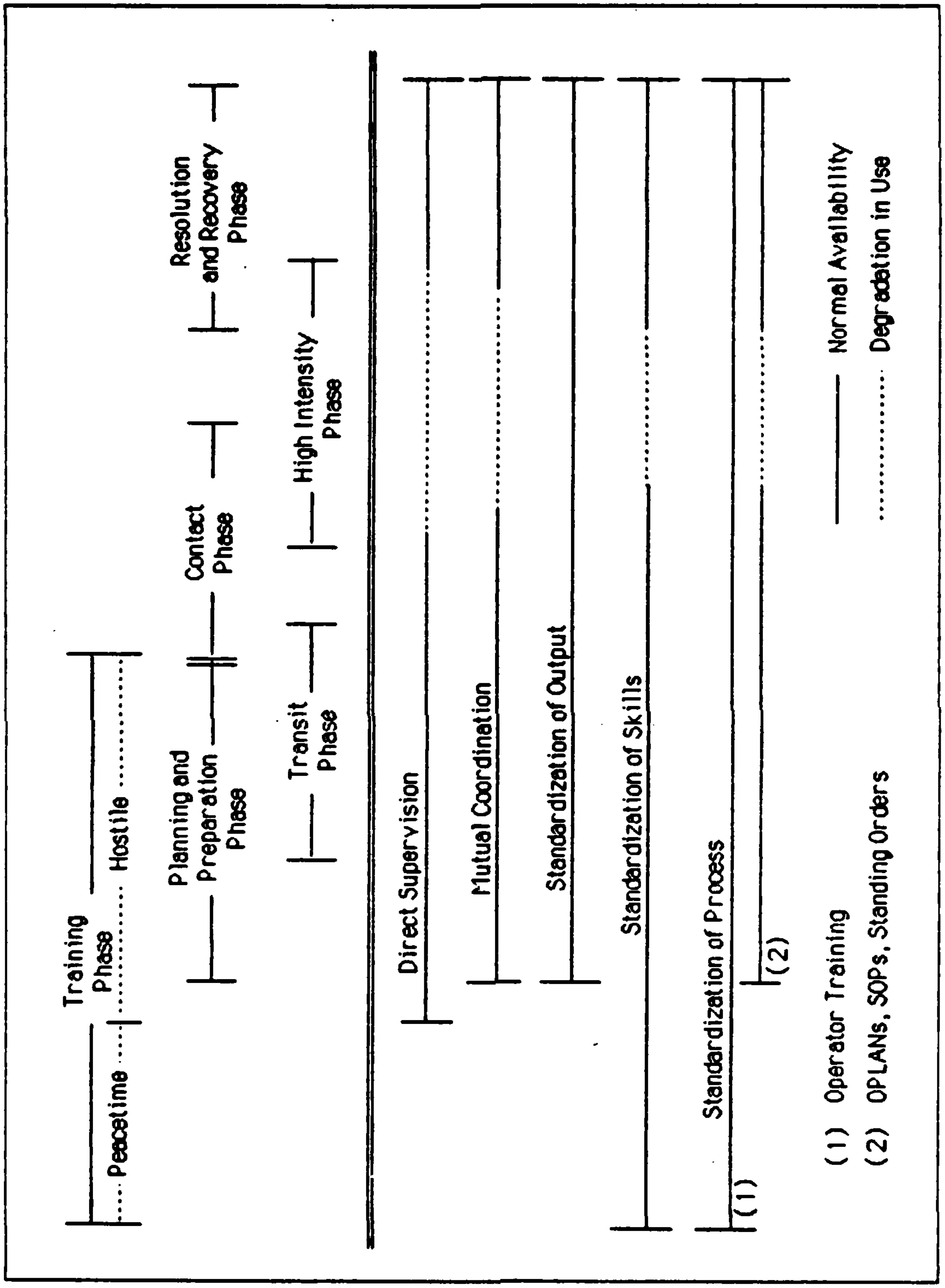


Figure 5.2 The Balanced Concept.

Application of the Balanced Concept for control of tactical warfare begins in the training phase, with standardization of skills and process. This is not to say that the other methods of control are not used here, but that they do not apply within the context of a direct relationship with a tactical operation. They are used primarily as administrative controls over logistics, maintenance and training during this phase. Standardization of skills and process, however, begin here as training that will carry over into the future--into the tactical operation. Without this kind of preparation in peacetime and, during the hostile component, prior to an operation, nothing could be accomplished without minute, specific, on-the-spot instructions.

With the beginning of the hostile component, direct supervision comes into play. The author chooses this point in time for the inception of direct control based on the belief that, once a period of tensions or hostilities begins, the operational chain of command will take priority, and there will be as few a number of reassignments of units as possible. In other words, the combatant organization will be stabilized, with the exception of replacements due to attrition. As previously discussed, the training phase continues concurrently with the planning and preparation phase, where the last of the coordinating mechanisms enter the mix.

It is in the planning phase that standardization of output enters in, as a mission objective(s) for the operation is selected. As this phase progresses, the objective(s) will be disseminated throughout the various levels of the force. The second component of standardization of process also is generated here, as the operation plans, standard procedures, and standing orders are composed, selected, and disseminated. Mutual

coordination should become evident during the planning process, as the various subordinate commanders, their staffs, and even unit commanders become involved in the production of the operation plans. Direct supervision continues through this phase, as does the operator training component of process standardization, and the standardization of worker skills. It must be emphasized here that throughout this phase, no coordinating mechanism should be degraded unless human error causes it to be. In reality, of course, the factor of human error will cause some failures, but for the purpose of defining the model, this factor will be considered minimal.

As the operation moves into the transit phase, all five methods of coordination remain available for the use of the force. In this case, however, direct supervision and mutual coordination begin to rely upon communications via radio and/or visual means, and up-to-date information on enemy forces is obtained via sensor assets. As EMCON is likely to be enforced, there is some restriction on the use of both radio and sensors, but as these restrictions are self-imposed, the availability at this point of direct supervision and mutual coordination as methods of control is considered normal. Standardization of skills and output also remain, as does the operator training component of standardization of process. The plans and procedures component may be subject to updates and changes during this period, but is also considered to be in effect.

All of these methods will remain effective into the first part of contact phase, where jamming and other methods of ECM will begin to reduce the use of communications, resulting in a degradation of control by direct supervision and mutual coordination. It is at this point that control by standardization of process and skills comes to the fore, with standardization of output driving their use. As the

operation moves into the high intensity phase, direct supervision and mutual coordination may be so reduced as to be eliminated, as damage to communications and sensor equipment, combined with continued ECM, makes transmission of information and orders to subordinate and lateral commanders virtually impossible. Also during this phase, operation plans may forcibly and unexpectedly be altered to deal with unforeseen contingencies, such as unexpected losses or inadequate intelligence on enemy capabilities. In such a case, the alteration of operations plans will rest upon one or more of the other coordinating mechanisms; for example, changes may be the result of direct supervision, in which the overall commander concentrates his efforts upon the generation of feasible alternatives. If direct supervision is so degraded that the OTC is unable to provide the necessary direction, commanders at all levels will of necessity revert to standardization of skills and output as methods of coordination.

Standardization of skills should remain unaffected during the high intensity phase. Assuming training was based upon the best knowledge available about the enemy, limitations upon this method of control become dependent upon prior intelligence and its incorporation into the training program. If, during the battle, the enemy is discovered to have new weapons or tactics of a kind revolutionary enough to make past doctrine inapplicable, standardization of skills will rest upon the individual commander's ability to innovate on the spot. In this situation, standardization of output remains effective, as achievement of the mission objective(s), by hook or by crook, will govern the commander's actions. Operator training also exists as long as the equipment is functional.

As the operation moves into the resolution and recovery phase, those methods of control which have suffered

degradation will be reconstituted along with the force. Direct supervision and mutual coordination will be restored in a manner directly related to the restoral of battle group communications. Standardization of output exists, insofar as mission instructions included "mop-up" operations and force reconsitution, but loses much of its impact as the operation is completed. Standardization of skills and of process are also effective, as damage control, maintenance and search and rescue procedures continue, and plans for force rendezvous, operation follow-up, and repair and resupply are initiated and carried out.

When viewed along a time continuum, as in Figure 5.2, the supplemental nature of the five coordinating mechanisms is more evident than in verbal description. Unfortunately, as can be seen in the diagram, four out of the five may suffer from some form of degradation during the high intensity portion of combat. What is to be hoped, is that a combination of all of them can make up for the individual failures in each, and that those that remain effective can bolster the force's overall effectiveness. For example, as direct supervision and mutual coordination become degraded due to failures in the ability of senior commanders to adequately process information, many decision-making functions will be decentralized. In such a case, the operation plans and the skills of lower-level commanders must function to reinforce the control process. Conversely, if the enemy's actions are so unexpected or innovative as to be beyond the tactical skills of the commmanders or to make the plan infeasible, direct intervention by the OTC would provide a method for controlling the situation. In other words, the OTC concentrates his attention on the big picture, dealing directly only with those situations his subordinates are unable to handle.

In this thesis, the Six Phases of Tactical Action and the five mechanisms of the Concept have been applied to the operation of a Fleet Battle Group. It is the author's contention that this same process can be applied to other forms of tactical warfare, with modifications to suit each situation. First, the six phases provide a method of defining the logical progression and characteristics of an operation, whether it be an amphibious landing or an air-land battle. Second, the superimposition of the five coordination mechanisms, in a mixed application, can allow the force's strengths and weaknesses in organizational control to be determined. Further analysis may, in fact, permit the identification of corrective measures for any weaknesses described. The author hopes that, at the very least, this model offers a descriptor of the most critical period in tactical command and control--the high intensity phase of combat--and has initiated a new orientation from which it may be viewed in order to find more innovative solutions.

Future work includes the design and development of a technique to relate a specific battle evolution to the Balanced Concept. In such a research effort a primary area for evaluation includes an analysis of the relation of each coordinating mechanism and the mutual reinforcement of all five which contributes to overall force effectiveness. Over a variety of specific evolutions such an effort will present an understanding of the choice of mix of the five mechanisms contingent on the evolution. Such an understanding would provide a basis for the relative emphasis to be placed on each mechanism during training and exercises. In addition the adaptation of the mix during a specific battle evolution would be understood and stand as a guiding principle to the commander.

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